Cross-Country Effects of Inflation on National Savings

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Abstract

Inflation is considered to be one of the most crucial factors in daily life since it has a direct impact on some people's savings. This paper seeks to examine whether or not there is a relationship between national savings and inflation rate. In a more complex multiple regression model, we take into account unemployment rate, HDI, population and income per capita. We found that inflation has a statistically significant positive effect on the national savings in both our simple and multiple regression models.

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1 Introduction

In economics, a country's national savings is the sum of private and public savings. Private saving equals to the amount of after tax income less the consumption. Public saving is government revenue minus government spending, which is usually negative. The national saving of the United States was increasing from 1985 to 2009 and decreasing from 2009 till now.

As we learnt in macroeconomics, an increase in the national saving rate leads to an initial decrease in consumption followed by an increase in consumption in the long run for most countries. Thus, policy makers must be extremely careful when considering whether or not to adopt policy that would possibly affect national saving. They should also pay attention to the factors that would possibly affect national savings, such as inflation.

The objective of this study is to find the effect of inflation rates on national savings. Our hypothesis is that inflation rate has positive effect on national savings because inflation brings uncertainty in future income and thus leads to a higher saving to hedge against risks. Cross sectional data sets are provided and STATA is used to interpret data sets and find how significant the effect is. The remainder of this paper is structured as follows. Section two briefly reviews related literatures. Section three discusses the data and provides descriptive statistics of the variables. Section four shows the STATA results and the interpretation. Section five concludes at last.

2 Literature Review

2.1 Findings from journals

In this section, we will examine previous researches and studies which relate with inflation and national savings. Since national saving is composed of personal saving and government saving, we will also survey articles about the relation between personal saving and inflation.

In *"Determinants of National Savings in Pakistan: an Exploratory Study"*(2013), the authors found that Pakistan's economy could sustain its expansion by raising its domestic saving rate. Thus, they attempted to explore the impact of various factors on national savings of Pakistan including GDP, inflation, fiscal deficit and rate of interest. However, there were two opposite theories about inflation. One theory suggests that national saving and inflation would be inversely related, while another theory suggests the opposite. A linear model is established using data(1973-2011) from the handbook of statistics of State Bank of Pakistan and website of World Bank. In conclusion, the authors found a significant negative impact of inflation on national savings in Pakistan.

In *"Personal Saving Behavior and the Rate of Inflation"*, Howard(1978) studied personal saving behavior in five major industrialized countries, using a model that incorporates most variables that are important for explaining personal saving. He found that in those countries, personal saving function and the ways where inflation influences personal saving are not all the same. For example, only in Japan and in the United States, unexpected inflation is strongly positively related to personal saving. In Canada, and in the United Kingdom, expected inflation has a similar but weaker effect. Overall, in all these countries, uncertainty of inflation tends to encourage personal saving. His research also reported that inflation is not the only variable that affects saving behavior, since he found a strong relationship between unemployment and personal saving in Canada, Germany, the United States, and the United Kingdom from his data sets.

In "Personal Saving and Anticipated Inflation", Bulkley(1981) used mathematical methods to provide a theoretical rationale for the relation between the rate of increase of inflation and the level of personal saving. He assumed zero population growth, zero technological change, zero real rate of interest and correctly anticipated inflation in his model. At last, Bulkley derived a positive correlation between inflation and personal saving.

In *"Determinants of Private Savings: The Case of Jordan"*, Hallaq(2003) analyzed the determinants of private savings in Jordan during 1976-2000 using the OLS and the instrumental variable methods. The main results indicated that the dependency ratio had a negative and significant effect on private savings, and government savings depressed private savings. However, GDP growth rate and GDP per capita income had a significant positive effect on private savings. Moreover, the development of Jordan consumer's credit market, the ratio of social security, and welfare public expenditures to total public expenditures appeared to have positive effects on private savings. Finally, the real interest rate, inflation rate, and terms of trade were found to have insignificant impact on the level of private saving in Jordan.

In *"The Effect of Interest Rate, Inflation Rate and GDP on National Savings Rate",* Mohamed(2014) investigated the effect of real GDP, interest rate and inflation rate on national saving rate in the Kingdom of Bahrain over the last twenty years. The author in his model questioned the view that inflation determines real returns to savings (the real interest rate), and thus will decrease the willingness to save. The findings of his study indicate that the inflation rate has positive and significant effect on national saving rate in both the short run and the long run.

2.2 Uniqueness of our project

In our study, we not only exam the relationship between inflation and national savings in a local scale, but also bring it up to international scope. Cross sectional data of more than one hundred countries are studied, and regression models are built based on all these countries national savings and inflation rate. These regression models are then tested for its assumptions and validity. As we can see from the literatures, two opposite points of view exist. Although the attitude on the correlation is still ambiguous, we try to verify our hypothesis. Since most of the previous work has been done within a nation, our research examines the effect of inflation rate between countries. Further, as to examine the correlation between inflation and national savings, we also take into account other controlled factors such as unemployment rate, population, income per capita and human development index. The significant level of these factors are studied, and compared to that of the Inflation rate.

3 Data

3.1 Data description

According to the literatures that we have gathered so far, there is a correlation between national savings and inflation. However, it is hard to tell which one is dependent and which is not, because to some extents, they are interdependent. As for this project, we only focus on the effect of inflation on the national savings.

It is not hard to show that inflation rate definitely has an impact on national savings if the inflation rate changes. After researching on the major influences of inflation, national savings is one. There are following reasons for such case:

- Inflation brings uncertainty in future income streams and can thus lead to higher saving in order to hedge against risks
- Consumers attempt to maintain a target level of wealth relative to income, and thus savings will rise with inflation.
- Countries with deeper financial systems tend to have higher private savings.

For this project, our sources of data are taken from World Bank and HDI, and we look at cross sectional data of different countries around the world. Data of inflation rates (Consumer prices) from year 2012 are collected.

Our simple regression model assumed that inflation is the only contributing factor to national saving, and thus the simple regression model contained only one variable, which is the inflation rate:

$$NS = \beta_0 + \beta_1 (inf)$$

We then try to include the factors of two more independent variables: population and income per capita. Population is included because country with higher population tends to have higher national saving with deeper financial system. It is also believed that country with higher income is more likely to save money, so we include income per capita in our model. We take the natural log of population, because population varies hugely among countries, and we wanted to scale it in a

logarithm way. Therefore, our multiple regression model follows:

$$NS = \beta_0 + \beta_1 (inf) + \beta_2 Ln(pop) + \beta_3 (inc)$$

In order to account for other factors such as unemployment rate, educational level, life expectancy, we finalized the model by adding unemployment rate and HDI. Unemployment rate is included because if the country has more people unemployed, then the country will have less income. HDI, indicating the development level of a country, may signify that country with higher development tends to have more savings. These adjustments led to our model with five independent variables as below:

$$NS = \beta_0 + \beta_1 (inf) + \beta_2 Ln(pop) + \beta_3 (inc) + \beta_4 (unemp) + \beta_5 Ln(HDI)$$

Where,

NS = National saving percentage of GNI

Inf = Inflation rate in percentage

pop = Population

HDI = Human Development Index (HDI is a composite statistic of life expectancy, education, and *income* indices used to rank countries into four tiers of human development.)

unemp = Unemployment rate in percentage

inc = Income per capita

3.2 Descriptive statistics

When we first collected the raw data from World Bank and HDI, the numbers of observations for different independent variables are not the same. Typically, we have the smallest sample size for unemployment rate. When merging the data together, we lost a proportion of data as well. However, in general, our sample size is sufficient to build a reliable model. Table 1 shows the descriptive statistics for all variables with inflation rate and national savings. Population and income per capita have the largest standard deviation as we expected, and only their log values were used later in our model. Table 2 provides the descriptive statistics of the data used in our finalized adjusted multiple model with complete observations of national savings, inflation rate, income per capita, population, unemployment rate and HDI. The sample sizes are different, because we have missing data from some of the variables, and for our adjusted multiple regression model, we can only use complete set of data of all five independent variables.

Table 1: Descriptive statistics of all data from 2012

Variable name	# of obs	Standard deviation	mean
National saving	153	13.108	11.460
Population	247	7.420E+08	1.980E+08
Inflation	210	6.397	5.562
Unemployment rate	107	6.309	9.001
Income per capita	200	14567.130	10415.582
HDI	165	0.158	0.688

Table 2: Descriptive statistics of complete observations from 2012

Variable name	# of obs	Standard deviation	mean
National saving	60	12.634	11.634
Population	60	9.114E+08	2.068E+08
Inflation	60	2.367	3.413
Unemployment rate	60	5.090	7.690
Income per capita	60	19515.159	20128.943
HDI	60	0.098	0.794

3.3 Gauss Markov assumptions

1) Linear parameters

   In our regression models, we model the effect of inflation on national saving in a linear manner. It is discussed in our results that our models are valid. Therefore, this assumption holds as our model is written in as a linear equation.

2) Random sampling

   We collect our data from World Bank and HDI across countries. When constructing the model, we use all the available data to build our regression model. Our data cover a wide range of countries, include both developed and developing countries, and they are only taken from year of 2012.

3) No perfect collinearity

   Table 3 shows the correlations between our independent variables. The value at the top

signifies the correlation coefficient between two variables, and the value at the bottom shows the P-value. P-value less than 0.05 provides information that the correlation coefficient is significant. As we can see from the table 3, we do not see high correlation coefficients. However, correlation coefficient between income per capita and HDI, with highest value of 0.717 and p-value less than 0.05, is relative high and significant. In the no perfect collinearity assumption, a correlation coefficient of 0.717 is not regarded as perfect correlation, and thus this assumption is not violated.

Table 3: Correlation between variables

	Inflation	Unemployment rate	Income per capita	HDI
Unemployment rate	-0.065 0.513			
Income per capita	-0.367 0	-0.113 0.267		
HDI	-0.441 0	0.026 0.82	0.717 0	
Population	-0.03 0.671	-0.19 0.05	-0.043 0.548	-0.009 0.906

4) Zero conditional mean

By constructing the simple regression model, we have stored the residual, and plotted the following chart (Figure 1). The mean of the residual is 4.944635E-15, which is statistically no different than 0.

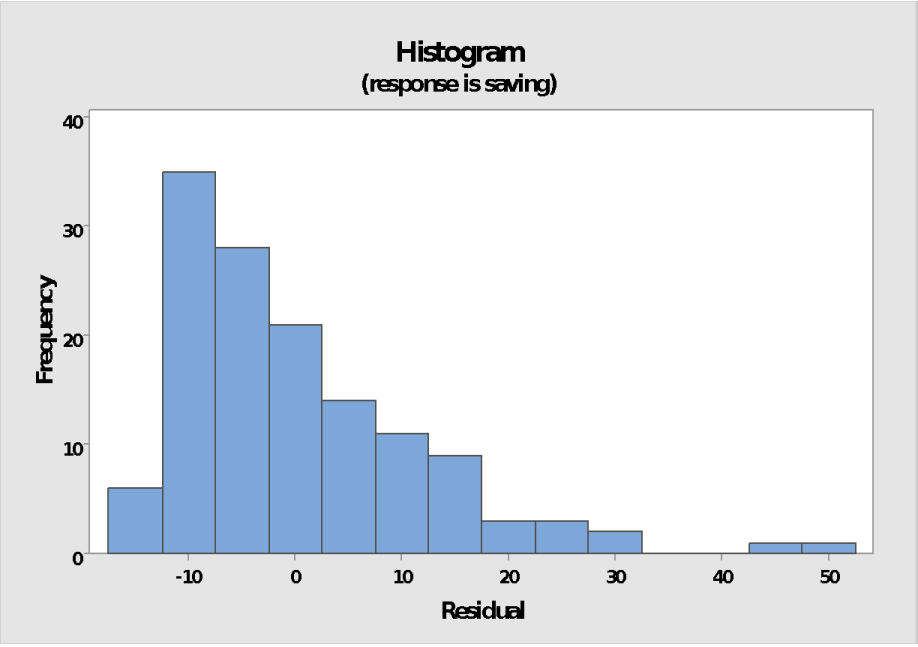

Figure 1: Residual histogram from simple regression model

We also plotted the residual histogram of our multiple regression model (Figure 2), and the mean turned out to be 8.171241E-15, which is again statistically same as 0. However, we can notice from the residual histogram that our multiple regression model has less skewer in residual histogram.

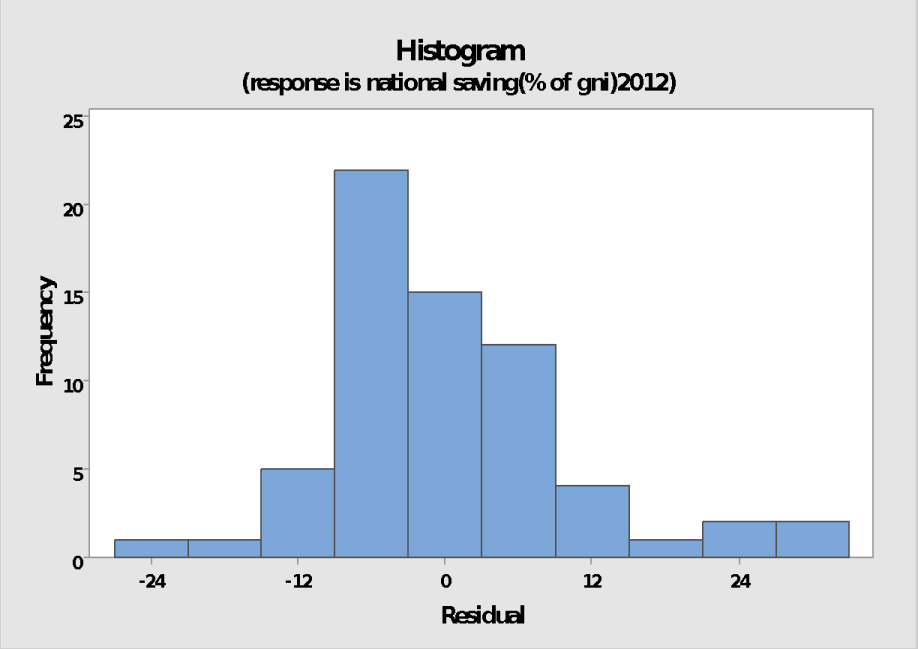

Figure 2: Residual histogram from adjusted multiple regression model

5) Homoskedasticity

By using STATA, we performed the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, and have the following result (Figure 3). chi2(1) = 1.3 and Prob > chi2 = 0.2458, indicating that our adjusted multiple regression model can hardly pass homoscedasticity test.

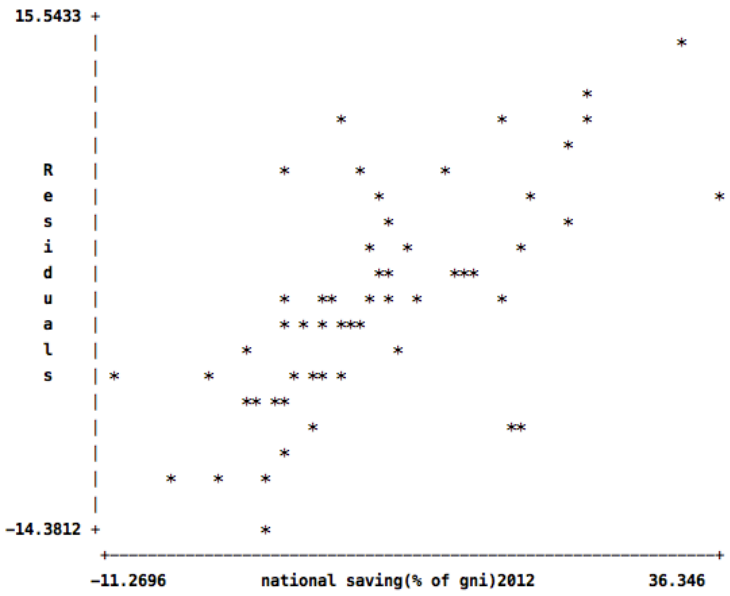

Figure 3: Residual vs. Dependent variable from adjusted multiple regression model

6) Normality

Using STATA, we plotted the following two residual plots (Figure 4). We can see from the plot that our sample residual from adjusted multiple regression generally falls a normal distribution.

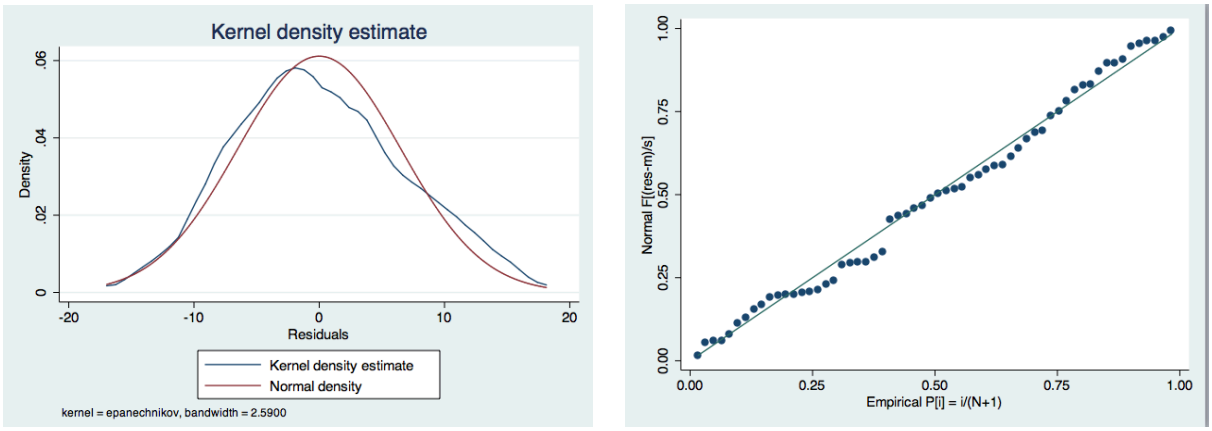

Figure 4: Kernel Density Plot and Standardized Normal Probability Plot

4 Results

4.1 Regression models

4.1.1 Simple regression model

We use STATA to build our simple regression model between national savings and inflation rate. The resulting equation is (Figure 3):

$$NationalSavings = 8.5272 + 0.6768 * InflationRate$$

There exists a positive relationship between saving and inflation. The R^2 value for our regression is 0.0377, indicating that the correlation is not strong but it does exist. The coefficient on the explanatory variable is 0.6768, meaning that one percent increase of inflation rate would increase the national savings by 0.6768 percent. The P-value is 0.018, confirming that inflation is statistically significant at 5% and 10% (Figure 5, Table 4).

Source	SS	df	MS
Model	933.362604	1	933.362604
Residual	23819.9755	147	162.04065
Total	24753.3381	148	167.252285

Number of obs	= 149
F(1, 147)	= 5.76
Prob > F	= 0.0176
R-squared	= 0.0377
Adj R-squared	= 0.0312
Root MSE	= 12.73

national~2012	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inflatio~2012	.6767781	.2819896	2.40	0.018	.1195009	1.234055
_cons	8.527177	1.692004	5.04	0.000	5.183382	11.87097

Figure 5: STATA output for simple regression model

4.1.2 Multiple regression model

We add ln(population) and income per capita to the explanatory variables for our first multiple regression model. The resulting equation is:

$$NationalSavings = -10.836 + 0.6276 InflationRate + 1.1229 ln(Population) + 0.0001 IncomePerCapita$$

Still regression model reflects a positive correlation between inflation rate and national savings. The coefficient on the explanatory variable is 0.6276, meaning that one percent increase of inflation

rate would increase the national savings by 0.6276 percent. Besides, ln(population) is significant at 1%, 5% and 10% with coefficient of 1.1229, meaning one percent increase in population will lead to 1.1229 percent increase national saving. With the addition of two more independent variables, we see an increase in both R^2 and adjusted R^2. The model with F = 4.56 larger that $F_{(3, 136)}$ is statistically significant. Though the P value of inflation slightly increased from 0.018 to 0.030, its inclusion in our model is still significant at 5% and 10%. So is the independent variable ln(population), with P-value of 0.006. However, we failed to reject the null hypothesis that income per capita and intercept are equal to 0, which means that they are insignificant. Figure 6 is the output from STATA.

Source	SS	df	MS
Model	1823.77517	3	607.925056
Residual	18138.4572	136	133.371009
Total	19962.2324	139	143.613183

Number of obs	= 140
F(3, 136)	= 4.56
Prob > F	= 0.0045
R-squared	= 0.0914
Adj R-squared	= 0.0713
Root MSE	= 11.549

national~2012	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inflatio~2012	.6276493	.2865401	2.19	0.030	.0609989	1.1943
lnpop	1.122858	.3992234	2.81	0.006	.3333694	1.912346
incomepe~2012	.0000408	.0000661	0.62	0.538	-.0000899	.0001714
_cons	-10.836	7.134305	-1.52	0.131	-24.94452	3.272524

Figure 6: STATA output for multiple regression model

4.1.3 Adjusted Multiple Regression Model

In the end, we added unemployment rate and HDI index to the explanatory variables for our adjusted multiple regression model. The resulting equation is (Figure 7, Table 4):

$$NationalSavings = 6.552 + 1.93 * InflationRate + 0.373 ln(Population) - 0.2566 IncomePerCapita - 8.218 HDI - 0.7718 UnemploymentRate$$

The model is more statistically significant with lower P value and much higher R^2 in comparison to the first two models. Among the independent variables, only inflation rate and unemployment rate are statistically significant at 1%. The coefficient on the explanatory variable inflation rate is 1.96, meaning that one percent increase of inflation rate would increase the national savings by 1.96 percent, with all other variables hold. The coefficient of unemployment rate is 0.7718, which means

one percent increase of inflation rate would decrease the national savings by 0.7718 percent. While Inflation rate has a positive correlation with national saving, the unemployment rate has a negative correlation with national saving. This aligns with our assumption, and high unemployment rate indicates a lower probability of having a high saving rate. However, HDI turns out to have a negative correlation with national saving, which is contrary to our anticipation that countries with higher human development index will be more developed in economic and have higher national savings. It is in fact very dubious to draw such a conclusion with HDI's P value higher than most of the significant levels (5%, 10%). Income per capita and ln(population), as in our first multiple regression model, still have a positive correlation with national saving, but this correlation is not statistically significant.

We also see that the P value of inflation rate decreased to 0.001. Usually when additional variables are included in the model, there are higher chances of multicollinearity within the model, and thus this will lead to an increase in P value on our baseline variables. However, we have a quite opposite outcome. One of the possible reasons is that we have different sample sizes for these three models. The first model takes into account data across 149 countries, the second model 140 countries, but the last model only accounts 60 countries. We notice that most of the missing data is from unemployment rate, which yields a very high significant level in our last model. With a different and smaller sample size, we might potentially have looked into a list of countries that experience stronger influence from inflation. And these countries' national savings are more likely to be influenced by inflation rate.

Source	SS	df	MS
Model	2900.46752	5	580.093505
Residual	2513.14157	54	46.5396587
Total	5413.6091	59	91.7560864

Number of obs	60
F(5, 54)	12.46
Prob > F	0.0000
R-squared	0.5358
Adj R-squared	0.4928
Root MSE	6.822

nationalsavingo~2012	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inflationcpi2012	1.821842	.4920489	3.70	0.001	.8353431	2.80834
lnpop	.3430206	.4999828	0.69	0.496	-.6593845	1.345426
incomepercapita2012	.0001061	.0000957	1.11	0.273	-.0000857	.0002979
unemploymentrate2012	-.7188083	.1853445	-3.88	0.000	-1.090402	-.3472149
hdi2012	-23.29877	19.41625	-1.20	0.235	-62.22601	15.62846
_cons	19.34236	18.43633	1.05	0.299	-17.62025	56.30497

Figure 7: STATA output for adjusted multiple regression model

4.1.4 Adjusted simple regression model

With the reasoning above, we decide to run an adjusted simple regression model among the same sample used in our adjusted regression model with 60 complete observations. The result is following (Figure 8, Table 4):

$$NationalSavings = 0.3312 + 2.54 * InflationRate$$

As anticipated, we have a quite strong model with high F statistic. Inflation rate is tested to be significant at 1%, 5% and 10%, and has a positive correlation with national saving. The coefficient of inflation rate is 2.54, highest among all models, which signifies that one percent increase of inflation rate would increase the national savings by 2.54 percent.

```
. reg nationalsavingofgni2012 inflationcpi2012 if complete == 1
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Source	SS	df	MS
Model	1906.05049	1	1906.05049
Residual	3507.55861	58	60.4751484
Total	5413.6091	59	91.7560864

Number of obs	60
F(1, 58)	31.52
Prob > F	0.0000
R-squared	0.3521
Adj R-squared	0.3409
Root MSE	7.7766

nationalsav~2012	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inflationcpi2012	2.541132	.4526354	5.61	0.000	1.635084	3.44718
_cons	.3311599	1.895091	0.17	0.862	-3.462278	4.124598

Figure 8: STATA output for adjusted simple regression model

Table 4: Complied results from STATA

Dependent Variable National Savings				
Independent Variables	Model (1)	Model (2)	Model (3)	Model (1)*
Inflation rate	0.677** (2.40)	0.628** (2.19)	1.822*** (3.70)	2.541*** (5.61)
Income per capita		0.0000408 (0.62)	0.000106 (1.11)	
ln(Population)		1.123*** (2.19)	3.43E-01 (0.69)	
Unemployment rate			-0.719*** (-3.88)	
HDI			-23.299 (-1.20)	
Intercept	8.53*** (5.04)	-10.836 (-1.52)	19.342 (1.05)	0.331 (0.17)
No. of obs.	149	140	60	60
R-square	0.0377	0.0914	0.5358	0.3521

* Significant at 10%, **5%, ***1%

Model (1): Simple regression model

Model (2): Multiple regression model

Model (3): Adjusted multiple regression model

Model (4): Adjusted simple regression model

4.2 Robustness tests

At this point, we want to test if the joint effect of unemployment rate, ln(population), income per capita and HDI is significant.

We use our adjusted simple regression (Figure 8) as our restricted model, and the adjusted multiple regression model (Figure 7) as our unrestricted model. The F statistic is:

$$\frac{(SSR_R - SSR_{UR})/q}{SSR_{UR}/(n-k-1)} = 5.344$$

From table, we have c = 2.2 for $\alpha = 0.1$, and c = 2.78 for $\alpha = 0.05$. Therefore, F statistic > c. we conclude that unemployment rate, ln(population), income per capita and HDI are jointly statistically significant at both 5% and 10%.

Further, we want to exclude unemployment rate, because in our adjusted multiple regression and the above robustness test, it has been tested to be significant. Including unemployment rate in our F test will always result in favor of the alternative hypothesis. Therefore, we run a regression model with only inflation rate and unemployment rate (Figure 9):

Source	SS	df	MS
Model	2791.89415	2	1395.94707
Residual	2621.71495	57	45.9949991
Total	5413.6091	59	91.7560864

Number of obs	60
F(2, 57)	30.35
Prob > F	0.0000
R-squared	0.5157
Adj R-squared	0.4987
Root MSE	6.782

nationalsavingo~2012	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inflationcpi2012	2.089093	.4079613	5.12	0.000	1.272165	2.906022
unemploymentrate2012	-.7776449	.1771977	-4.39	0.000	-1.132477	-.4228126
_cons	8.160434	2.431905	3.36	0.001	3.290628	13.03024

Figure 9: STATA output for robustness test

The F statistic calculating based on the above model (Figure 9) as restricted and our adjusted multiple regression model as unrestricted equals 0.7794. Therefore, we failed to reject the null hypothesis that the coefficients of ln(population), HDI ad income per capita all equal to zero. Thus the joint effect of ln(population), HDI and income per capita is insignificant.

5 Conclusion

Our results show that inflation rate has a significant positive effect on national savings (percentage of GNI). This result is what we expected when considering the economic principles on the relationship between inflation rate and national savings.

Further, we realized that some other variables might be related with national savings. For example, more income would lead to more savings; higher unemployment rate would decrease the amount of people who has money to save, and thus decreases savings; etc. We introduced these factors to our multiple regression model and we found both inflation rate and unemployment rate are statistically significant.

In the future, it is still beneficial to explore the effect of inflation rate on the national savings. This correlation would be interesting to examine and possibly useful for policy makers to consider about policies related with these factors. In our model, although the regression supports the hypothesis, the data we found from the World Bank is not very complete. The missing data would even potentially reverse the result of our finding. However, the existence of the correlation cannot be overlooked and our results would help assess the relevancy between these factors.

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